



Published in final edited form as:

J Cancer Surviv. 2014 December ; 8(4): 697–706. doi:10.1007/s11764-014-0386-y.

Searching for maintenance in exercise interventions for cancer survivors

Catherine M. Jankowski,

College of Nursing, University of Colorado, Mail Stop C288-19, 13120 E. 19th Avenue, Aurora, CO 80045, USA

Marcia G. Ory,

Department of Health Promotion and Community Health Sciences, Texas A&M Health Science Center, 1266 TAMU, College Station, TX, USA

Daniela B. Friedman,

Department of Health Promotion, Education, and Behavior & the Statewide Cancer Prevention and Control Program, University of South Carolina, 915 Greene St, Columbia, SC 29208, USA

Andrea Dwyer,

School of Public Health, University of Colorado, Mail Stop F538, 13001 E. 17th Place, Aurora, CO 80045, USA

Sarah A. Birken, and

Lineberger Comprehensive Cancer Center, University of North Carolina at Chapel Hill, CB 7411, UNC-CH, Chapel Hill, NC 27599-7411, USA

Betsy Risendal

School of Public Health, University of Colorado, Mail Stop F538, 13001 E. 17th Place, Aurora, CO 80045, USA

Catherine M. Jankowski: catherine.jankowski@ucdenver.edu

Abstract

Purpose—Translating evidence-based exercise interventions into practice is important for expanding the capacity to support cancer survivors. Using the reach, efficacy/effectiveness, adoption, implementation, and maintenance (RE-AIM) framework and scoping study methodology, we addressed the research question, “What is known about the maintenance of exercise interventions for cancer survivors that would inform translation from research to practice and community settings?” Maintenance was investigated at the individual and setting level.

Methods—Literature searches were performed in the PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Sport Discus databases for articles published from January 2009 to June 2012. Abstracts were judged using a priori criteria for the survivor population, exercise intervention, and maintenance on the individual or setting level. We included

Correspondence to: Catherine M. Jankowski, catherine.jankowski@ucdenver.edu.

Conflict of interest

Authors Jankowski, Ory, Freidman, Dwyer, Birken, and Risendal have no conflict of interest.

completed and planned randomized controlled trials (RCTs) and other study designs. Publications meeting the criteria were reviewed and coded.

Results—Of the 211 abstracts meeting patient and exercise criteria, 24 (19 RCTs) met the maintenance criteria. Nine of the 12 completed RCTs demonstrated maintenance of intervention outcomes after 3 to 14 months of follow-up. The planned RCTs described interventions lasting 2 to 4.5 months and maintenance intervals lasting 3 to 12 months following the active intervention. Maintenance at the setting level was reported in one publication.

Conclusions—On the individual level, intervention outcomes were maintained in most studies, in a variety of settings and survivor subpopulations. Maintenance on the setting level was scarcely addressed. This scoping study suggests several strategies that could be taken by agencies, clinicians, and researchers to develop more effective and sustainable exercise programs for cancer survivors.

Implications for Cancer Survivors—Many benefits of exercise training are maintained for months after cancer survivors complete controlled research studies but relatively little is known about how to translate research to sustainable community-based exercise programs. A better understanding of how programs can be sustained in practice beyond short-term research or grant funding is needed to support a growing number of survivors.

Keywords

Cancer survivor; Exercise; Physical activity; RE-AIM; Scoping study

Randomized controlled trials (RCTs) have formed the evidence base for the many positive effects of exercise interventions on physical and mental health outcomes [1]. The quantity of hypothesis-driven RCTs of exercise interventions for cancer survivors has increased greatly in recent years and contributed to specific evidence-based exercise recommendations for this rapidly growing population [2]. However, the emphasis on internal validity in RCTs can limit the external validity of the findings and may hinder translation of clinical exercise research into practice and community settings [3]. The reach, efficacy/effectiveness, adoption, implementation, and maintenance (RE-AIM) framework is a method to evaluate the public health impact of an intervention from RCTs or other study designs [4]. White et al. [3] recommended strengthening the external validity of exercise RCTs in cancer survivors by applying the (RE-AIM) framework [5], yet there has been little research utilizing RE-AIM in cancer survivorship research. To the best of our knowledge, only one exercise RCT of cancer survivors incorporated the RE-AIM framework [6].

As clinical exercise research in cancer survivorship grows and matures, more investigators are likely to adopt the RE-AIM framework or other methods of evaluating research translation. However, the need to increase the capacity of safe and effective exercise programs for cancer survivors is imminent because of the increasing number of survivors. It is projected that the number of cancer survivors will increase from 13.7 million in 2012 to nearly 18 million by 2022 [7]. The Institute of Medicine [8] has called on health care providers to provide all patients completing primary treatment with a care summary and follow-up plan. Physical activity and exercise will be an important component of these “Survivorship Care Plans.” Hence, we conducted a scoping study of exercise interventions

for cancer survivors. Unlike systematic reviews that focus on the effect size of outcomes from RCTs meeting a strict set of criteria, a scoping study gathers contextual information from a broader range of publications. As seen in Fig. 1, the translation of research into practice involves conceptual underpinnings (e.g., a focus on implementation, dissemination, and maintenance processes) [5], methodologies (e.g., greater emphasis on external validity), and context (e.g., characteristics of the settings, interventions, and participants) [9].

Wanting to make a unique contribution to translation research, we decided to focus on the maintenance construct of RE-AIM, defined as the extent to which intervention effects are maintained over time at both individual and setting (i.e., organizational) levels [5]. An example of maintenance at the individual level is the extent to which an individual continues an exercise behavior change after a period of supervised exercise training. An exemplar of setting-level maintenance is the delivery of exercise recommendations to cancer survivors at a clinical site after grant funding has ended. This scoping study addressed the research question, “What is known about the maintenance of exercise interventions at the individual and setting levels for cancer survivors that would inform translation to practice and community settings?” The primary objectives were to (1) describe the scoping process that was undertaken; (2) examine the extent to which individual- and setting-level maintenance was or will be achieved in completed or proposed RCTs and other study designs, including attention to study attrition; and (3) recommend strategies that could be taken by agencies, clinicians, and researchers to develop effective and sustainable exercise programs for cancer survivors.

Methods

Scoping methodology is an iterative process that is guided by the literature search, refinement of the research question, and consensus by the research team on decisions related to operational definitions, limits of the scoping study, and criteria for the inclusion and exclusion of publications [10]. We applied the scoping study methodology of Arskey and O’Malley [11] as modified by Levac et al. [10]. The framework of this method is to (1) identify the research question; (2) identify relevant studies; (3) refine the selection; (4) chart (i.e., code) the data; and (5) collate, summarize, and report the results.

Literature search strategy

Searches were performed in the PubMed and Sport Discus databases using the key words “cancer survivor” with “exercise,” “exercise implementation,” “evidence-based exercise,” “exercise translation,” “exercise health promotion,” and “exercise rehabilitation.” The initial time frame for publications was January 1980 to June 2012. The timeframe was selected because the earlier systematic review by White et al. [3] included publications through 2008. In contrast to White, our search was broader in that it was not limited to a specific cancer type or to RCTs. Additional searches of PubMed (US National Library of Medicine, Bethesda, MD), the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the Library of Congress (Washington, DC) databases were completed by a research librarian to confirm the results of the initial search. The citation collection was archived using End-Note software (Thomson Reuters, 2012; New York, NY).

Identification of relevant publications

The abstract of each citation in the collection was reviewed using a priori criteria. The inclusion criteria for abstracts were that the survivor population was described (e.g., race, sex, cancer type) and exercise of any type was the main component of the intervention. Additionally, at least two of the following criteria were required: (1) the delivery and/or setting of the intervention (e.g., individual or group-based delivery, home or health care setting); (2) duration of the intervention (e.g., weeks); and (3) intensity of exercise (e.g., mild, moderate, high, or relative to peak performance) or frequency of exercise (e.g., number of days per week). If an abstract was very brief but the title suggested that it might meet the inclusion criteria, the full manuscript was reviewed. Publications that described study design and methodology, but not the results, of RCTs were retained for further consideration. The rationale for including studies in progress was to survey how investigators were planning to incorporate measures of maintenance in their research that is likely to be reported in the next few years. After this initial screening step, we retained articles that focused on the maintenance of exercise programs for adult cancer survivors in publications from January 2009 to June 2012 by adding the keyword “maintenance” to this subgroup of abstracts.

In keeping with scoping methodology, our initial search strategy included grey literature (i.e., sources other than biomedical databases). The identified citations were either secondary reporting of published studies or did not meet inclusion criteria. Therefore, we discontinued further searches of the grey literature.

Screening of abstracts

Abstracts were screened using a two-step process. In the first screening step, teams from the University of Colorado and Texas A&M Health Science Center independently reviewed the abstracts to determine if inclusion criteria were met. The teams compared their decisions and, when discordant, reached consensus through discussion. In the second screening step, abstracts were judged on “maintenance,” defined as (1) a measure of follow-up of any duration after the exercise program/intervention ended (individual level of maintenance), (2) measurement of continuation/discontinuance (or of intent to measure follow-up in methods papers), or (3) observations about follow-up at the individual or setting level.

Coding of publications

The retained publications were coded using a form developed by the research team in an iterative process. The coding form included variables adopted from the RE-AIM Framework Construct Checklist (<http://cancercontrol.cancer.gov/IS>). The study team tested the form by coding five retained publications in duplicate and commenting on the form. The coding form was revised by three investigators (CMJ, MO, SAB) and the remaining publications were coded one time. Select fields in the completed coding forms were reviewed against the original publication for accuracy and corrections were made prior to data synthesis. If a publication included maintenance data from a previously published study (e.g., secondary outcomes from the seminal publication), the seminal article was retrieved, coded, and included as background information.

Maintenance was addressed on the individual (i.e., participant) and setting (i.e., organizational) levels. On the individual level, maintenance was described by the time interval from the final active intervention visit, the number of data collection time points in the maintenance interval, the primary outcome(s) of the maintenance phase, and the significance of the statistical test(s). An intervention effect was considered “maintained” if the change in the outcome was significantly different from baseline (i.e., baseline versus post-intervention) and not significant during the follow-up period (i.e., post-intervention versus end of follow-up).

Study attrition was defined as the percent of those participants enrolled who were absent in the maintenance phase and reported as the median and range for all studies. Intervention attrition was calculated as the percent of participants enrolled who were absent at the end of the intervention. Maintenance on the setting level was evaluated by the setting, outcomes, and characteristics including whether the program or intervention was ongoing, adapted for the long-term, aligned to an organizational mission, or if the sustainability of a business model (i.e., sources of funding, cost to participants, cost of program) were discussed (<http://cancercontrol.cancer.gov/IS>).

Results

Database searches

Of the 377 publications identified in the database searches, 211 abstracts were reviewed for eligibility based on patient and exercise intervention criteria (100 RCTs and 111 other types of studies). This subset was then filtered using the maintenance criteria, leaving 24 publications (19 RCT publications) in the collection. One RCT yielded 2 publications with maintenance data [12, 13], thus the 19 publications in the RCT collection represented 18 unique trials or 8.5 % of studies that reported on maintenance of some type. In addition to the RCTs, we included 5 publications that used qualitative methods, longitudinal surveys, or a secondary regression analysis of results from a RCT (Fig. 2).

Randomized controlled trials (RCTs)

Twelve publications represented completed RCTs and seven described planned RCTs. Among the retained RCT publications, mixed cancer types and breast cancer were in the majority (Fig. 2). Of the completed RCTs (Fig. 3a, Table 1), four interventions were home-based [14–17], four were supervised and conducted in an academic health care setting [12, 13, 18, 19], and the others were supervised and home-based exercise [20, 21], group counseling with home-based exercise [22], or supervised exercise with or without group counseling in a clinical setting [23]. The median (range) duration of active intervention intervals (intervention) was 3 months (1.5–10) and duration of the maintenance intervals was 6 months (3–14). Two studies measured maintenance at two time points [16, 23]. The most common primary outcome of the interventions was minutes of exercise, followed by physical function, menopausal symptoms, quality of life, weight loss, and fatigue.

Completed RCTs—In 9 of the 12 completed RCTs, the significant changes in the primary outcomes were maintained at follow-up [13–15, 18–23]. The primary outcomes of exercise

minutes and fatigue were maintained in two [14, 15] of the four home-based exercise trials. However, it should be noted that the two home-based exercise RCTs where maintenance was not demonstrated [16, 17] had longer follow-up periods than any of the other trials. No RCT assessed maintenance at the setting level (Fig. 3, Table 1).

Study sample sizes varied widely from a pilot study with 10 enrolled survivors [20] to over 600 in a mail- and telephone-delivered intervention [17]. The median (range) study attrition was 18 % (10–44 %). The greatest attrition (44 % from enrollment to end of the maintenance interval) was found in a study of 50 advanced prostate cancer patients (average age 72 years) receiving androgen suppression therapy [19]. They were enrolled in a semi-supervised, 12-week aerobic and resistance exercise program followed by a 6-month maintenance interval. Most of the attrition (35 %) occurred between the end of intervention and the end of the maintenance interval. The reasons for attrition during the maintenance phase were the development of unrelated health problems and non-response to contact. The lowest attrition (i.e., best retention at 90 %) was found in a study of 122 lymphoma patients (average age 53) who completed a 12-week supervised aerobic exercise intervention followed by a 6-month maintenance interval [12, 13]. Physical activity (self-reported minutes of exercise) and physical function (self-reported) were significantly increased during the exercise intervention, but only physical activity was maintained during follow-up [12, 13].

Planned RCTs—The planned RCTs included three with combined supervised and home-based exercise [24–26], three trials in a rehabilitation setting (described in one publication) [27], and one study each in the health care [28], community fitness [29], and clinical research [30] settings. Aerobic fitness and physical activity levels (e.g., exercise minutes or step counts) were the most common primary outcomes in the planned RCTs (Fig. 3, Table 2).

The median (range) active intervention and maintenance intervals proposed were 3 months (2–4.5) and 9 months (3–12), respectively. Three studies proposed two follow-up contacts [25, 26, 29]. One publication included three planned RCTs [27]; therefore, the five publications included eight planned interventions. The planned enrollment in these studies was 64 to 400 survivors. Expected enrollment attrition of 10–20 % was presented in four publications. No publications included estimates of attrition during the maintenance phase.

Other study designs

We included five publications that provided contextual information about the maintenance of exercise effects on the individual level [31–35]. One of these publications [35] also included maintenance on the setting level. Due to the diversity of these publications, we present the contextual aspects of each study. Courneya et al. [33] identified several independent predictors of exercise maintenance in breast cancer survivors 6 months after a 4-week, supervised aerobic or resistance exercise training intervention during chemotherapy. Women who were younger (<50 years), exercised more before enrollment, had breast-conserving surgery, greater strength gains from training, a more positive attitude about

resistance training, less fatigue, and a lower BMI at the end of training were more likely to maintain exercise [33].

Two longitudinal survey studies [31, 32] provided insight about trends in physical activity up to 3 years after diagnosis. Change in physical activity (MET-hours/week) was assessed for 30 months in women diagnosed with primary invasive breast cancer and increased risk of lymphedema [31]. In the 12 months after diagnosis, physical activity decreased about 50 %. Between 12 and 18 months post-diagnosis, physical activity increased for low, moderate, and vigorous physical activity, and then remained stable from 18 to 30 months post-diagnosis. Women who were younger (<40 years), had a BMI <25, and were more active before cancer diagnosis had the greatest reduction in physical activity and did not rebound to their pre-diagnosis physical activity level.

Chambers et al. [32] surveyed colorectal cancer survivors 5, 12, 24, and 36 months after diagnosis to determine the relationship between psychological distress and physical activity over time. At study entry, higher levels of somatization and anxiety were associated with inactivity. Over time, psychological distress did not motivate colorectal cancer survivors to become more physically active. The authors [32] suggested that cancer survivors with high levels of anxiety after diagnosis and ongoing somatization may benefit from interventions that combine psycho-education, exercise, and other lifestyle changes that mitigate the physical symptoms of stress.

To better understand self-determination and illness resistance in cancer survivors, Midtgaard et al. [34] studied a subset of survivors who were sedentary prior to enrolling in the Copenhagen PACT study and then exercised at least 3 days per week for the next 18 months. Five categories relevant to the maintenance of exercise behavior emerged from interviews with survivors. Survivors who maintained exercise behaviors (1) were able to decide on a new agenda in life, (2) saw physical activity as an act of autonomy, (3) acknowledged the importance of goal setting, (4) prioritized physical activity, and (5) tamed fear.

Setting-level maintenance

Evidence for setting-level maintenance was scarce. Fitzpatrick et al. [35] included setting- and individual-level maintenance perspectives in their study of wellness programs for cancer survivors. Their study was driven by underutilization of a wellness center for cancer survivors during its first year of operation (Hope & Cope Wellness Center, Montreal, Canada). One-third of the survivor registrants (148 of 464) never returned to participate and nearly half of registrants participated less than three times in 1 year. For a comparison of utilization trends, 18 other wellness centers for cancer survivors in the USA and Canada were contacted. A consistent finding was that one-third of registrants attended less than three times. Anecdotally, the centers' staff attributed poor attendance to participants' health status, medical appointments, and family responsibilities; weather; and suitability of the survivor groups. These were primarily individual-level (i.e. survivor-related) reasons. Setting-level reasons for under-utilization included inadequate recording of attendance, lack of referrals from community organizations, competition from cancer support groups, and insufficient financial resources for services. Insufficient financial resources suggest lack of

sustainability of the business model. This is the only evidence in our review of attention to sustainability of a business model supporting an exercise program for cancer survivors.

Fitzpatrick and colleagues [35] then conducted telephone interviews with participants who never ($n=16$) or seldom ($n=17$) attended the Hope & Cope Wellness Center. From these interviews, several setting-level strategies to improve attendance were proposed. First, a consistent system of follow-up communication between staff and infrequent users should be in place, including a standardized method for recording survivors' reasons for not attending. The responses could be used to modify programs and attendance monitored for the effectiveness of the modifications. Second, improve accessibility by linking survivors with appropriate community fitness programs; provide virtual support (online modules, links, chat rooms); and extend hours of operation. Third, provide support and services for family caregivers using center-based and virtual delivery. These findings and strategies addressed the RE-AIM components by assessing the settings of the wellness programs, with the focus on utilization in this case, and adapting programs for the long-term.

Discussion

The purpose of this scoping study was to survey and summarize the evidence for the maintenance of outcomes following exercise interventions for cancer survivors. Our main finding was that only 8.5 % of reviewed publications between 2009 and 2012 included a maintenance interval or addressed observations related to exercise maintenance. Of the few RCTs of exercise that included a maintenance component, the majority demonstrated durable effects of the intervention in cohorts representing at least six different cancer types, a wide range of age, and time since last treatment. Additionally, some studies targeted survivors with persistent side effects including fatigue [15], body pain [20], and menopausal symptoms [18]. This result was promising, at least for near- to moderate-term maintenance, and points to the need for continued and expanded monitoring of outcomes to further delineate the characteristics of exercise interventions that could translate to effective, agreeable, and sustainable exercise programs serving a variety of survivor subpopulations.

The durability of exercise effects was more consistent in interventions delivered in settings other than home-based. However, this observation is confounded by other characteristics such as the method of delivery (mailer with [17] or without [16] telephone counseling) and the longer duration of follow-up in two of the home-based RCTs [16, 17]. Among the completed RCTs, the type of exercise varied considerably, including stationary cycling [12, 13]; walking [14, 21, 22]; resistance exercise combined with unspecified aerobic exercise [23], with stationary cycling [19], or with walking or cycling plus flexibility training [20]; yoga [18]; and physical activity (walking, cycling, housekeeping, gardening; [15]). For endurance exercises, the most commonly prescribed type, intensity was described as a percentage of maximal heart rate [20, 23] or oxygen consumption [12, 13], more generally as moderate to vigorous [16, 21], or was not specified [14, 15, 17, 22]. In all settings, the maintenance of exercise effects was demonstrated more consistently within shorter (3–6 months) follow-up intervals. The planned RCTs have the potential to meaningfully expand our understanding of exercise maintenance given that six of the nine planned RCTs have longer (6–12 months) intervals.

A limitation of the maintenance analysis is that we operationally defined individual maintenance of an outcome as a statistically significant change from baseline to post-intervention and no significant change from post-intervention to follow-up. However, the RCTs were not powered for the maintenance of outcomes that would have required greater enrollment at study entry to account for attrition during follow-up. The estimated study attrition in the planned RCTs was 10–20 %, which is consistent with the median 18 % attrition rate in the completed RCTs, although wide variation in attrition was found. Larger sample sizes will be needed to adequately power studies for maintenance outcomes. The attrition rates of the completed RCTs were superior to attendance in wellness programs, wherein almost 50 % of registrants never or seldom attended activities [35].

We found no completed RCTs and only one planned RCT [29] in community settings that addressed maintenance outcomes. Additional support may be needed to help community program managers collect and evaluate maintenance data. Furthermore, only one other publication addressed maintenance at the setting level [35]. As more programs will be needed to meet the needs of a growing number of survivors [7], understanding how programs can be sustained by agencies or institutions beyond short-term research or grant funding is sorely needed.

Several strategies could be adopted by community agencies, clinicians, and researchers to develop effective sustainable exercise programs for cancer survivors. Researchers, clinicians, and community program directors could collaborate to define a tracking framework that links individuals to organizations (e.g., a community resource guide). Clinicians and health care systems could consider the use of electronic health records to prompt initial referrals and follow-ups to appropriate exercise programs, measure key outcomes, and track maintenance of outcomes over time frames consistent with medical monitoring of survivors. A standard protocol of physical and functional outcomes, standard follow-up intervals, and uniform data collection plans could capture individual-level data across exercise programs. For example, Chinapaw and colleagues [27] proposed three exercise RCTs in adult cancer survivors (and a fourth in childhood cancer) in the Alpe d'HuZes Cancer Rehabilitation (A-CaRe) program that will be conducted across a network of clinical sites in the Netherlands. The A-CaRe studies will share common outcome measures selected from the International Classification of Functioning, Disability, and Health of the World Health Organization [36]. Data from standardized outcomes could also be used to evaluate the effectiveness of implementation and dissemination strategies for promoting evidence-based exercise recommendations. Our findings suggest that further work is needed to illuminate how programs are, or can be, financially sustained in various settings based on the lack of information provided in the literature. Fiscal analysis such as operating cost per participant, private and public funding acquisitions, and qualities of successful referral mechanisms could be used to capture setting-level outcomes to evaluate and predict sustainability.

We focused on studies that included an element of “maintenance” on the individual or setting level, according to the RE-AIM framework. Rogers et al. [6] incorporated the RE-AIM framework to investigate the feasibility of a supervised exercise intervention that transitioned to the home setting in a study of breast cancer survivors. In a rehabilitation

example, the RE-AIM approach was applied to the translation of falls prevention interventions from research to community settings [37]. We decided to include publications describing planned RCTs to provide a snapshot of the near future in the discipline of cancer rehabilitation. The investigators of the planned RCTs made a decision to consider the translation and adoption of their intervention by including at least one follow-up time point after the completion of the exercise intervention. The intention to consider the translation of interventions beyond the research setting is a key feature of the Knowledge to Action (K2A) framework [38–40]. Although RCTs, by virtue of funding and scientific rationale, often end when the active intervention ends, investigators could consider a partnership with community stakeholders to add a “bedside to community” sustainability phase to their studies.

Limitations of this report include restriction to English language publications dated 2009 to 2012. Additional publications that fit our search criteria have appeared in the literature in the interim. For example, Cormie et al. [41] found that improvements in walking pace and participation in mild intensity exercise were maintained 6 months after the completion of a 3-month resistance exercise intervention in women and men with bone metastases. Some readers might view the use of the scoping approach rather than the standard Cochrane-type review focused on average effect size as a limitation. On the other hand, we think the scoping review, by permitting latitude in forming the collection of publications to answer a research question, provides a unique view of the literature and better matches the contextual implementation science questions presented and the multi-level qualities of maintenance [42]. For example, comparison of our results to those previously described in the review by White et al., which included only randomized controlled trials of breast cancer survivors, suggests that the scoping study methodology provided new insights to long-term maintenance of physical activity behaviors as well as the role of psychological factors in predicting adherence. Notably, the review by White et al. similarly found that program maintenance and costs were not typically reported with trial results, further suggesting that the need for reporting of these data is paramount in future programs. Scoping methodology has been used in other health care settings, such as the integration of physical rehabilitation into primary care. Strengths include the standardized retrieval processes, the contextual information provided, the inclusion of studies in the field to assess near future reporting trends, and the use of RE-AIM to focus on two key, under reported maintenance dimensions [4, 43, 44].

Although the number of programs identified through our scoping study is relatively small, the results point to some provocative trends in terms of the relationship between the durability of intervention effects and characteristics of cancer survivors that could be the focus of future investigations to improve maintenance. For example, of the five contextual studies included in our review, current beliefs and attitudes about physical activity were important factors that could be impacted in future interventions. Future investigations are needed to discern whether or not beliefs and attitudes can ameliorate the influence of age, psychosocial distress, and other relevant co-factors on adherence. Our intent was to address the translational gap between hypothesis-driven RCTs with generally strong internal validity and the maintenance of exercise programs that emphasize external validity. A paucity of maintenance outcomes on the organizational level currently hinders this translation.

Although individual-level maintenance was measured in less than 10 % of publications in the scoping timeframe, the outcomes of exercise interventions for cancer survivors were durable. Future exercise intervention studies with longer follow-up periods will contribute to the maintenance profile.

Acknowledgments

The authors are grateful to Richard Wood and Alice Franco for organizing the publication searches and to Russell E. Glasgow for his critique of the manuscript. Funding for this research was supported by Cooperative Agreement Number 5U48DP001938(03) and 1U48 DP001924 from the Centers for Disease Control and Prevention. The findings and conclusions in this manuscript are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

References

1. Services USDoHaH. , editor. PAGA Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, D.C.: 2008.
2. Schmitz KH, Courneya KS, Matthews C, Demark-Wahnefried W, Galvao DA, Pinto BM, et al. American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. *Med Sci Sports Exerc.* 2010; 42(7):1409–26. Epub 2010/06/19. [PubMed: 20559064]
3. White SM, McAuley E, Estabrooks PA, Courneya KS. Translation physical activity interventions for breast cancer survivors into practice: an evaluation of randomized controlled trials. *Ann Behav Med.* 2009; 37:10–9. [PubMed: 19255819]
4. Gaglio B, Shoup JA, Glasgow RE. The RE-AIM framework: a systematic review of use over time. *Am J Public Health.* 2013; 103(6):e38–46. Epub 2013/04/20. [PubMed: 23597377]
5. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health.* 1999; 89(9):1322–7. Epub 1999/09/04. [PubMed: 10474547]
6. Rogers LQ, Hopkins-Price P, Vicari S, Pamentier R, Courneya KS, Markwell S, et al. A randomized trial to increase physical activity in breast cancer survivors. *Med Sci Sports Exerc.* 2009; 41(4):935–46. Epub 2009/03/12. [PubMed: 19276838]
7. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012. *CA Cancer J Clin.* 2012; 62(1):10–29. [PubMed: 22237781]
8. National Cancer Policy Board. From cancer patient to cancer survivor: lost in transition. Washington, D.C.: 2005. p. 9780309095952
9. Glasgow RE, Magid DJ, Beck A, Ritzwoller D, Estabrooks PA. Practical clinical trials for translating research to practice. Design and measurement recommendations. *Med Care.* 2005; 43(6): 551–7. [PubMed: 15908849]
10. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implementation Science.* 2010; 5(69)
11. Arskey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Res Methodol.* 2005; 8(1):19–32.
12. Courneya KS, Sellar CM, Stevinson C, McNeely ML, Peddle CJ, Friedenreich CM, et al. Randomized controlled trial of the effects of aerobic exercise on physical functioning and quality of life in lymphoma patients. *J Clin Oncol.* 2009; 27(27):4605–12. Epub 2009/08/19. [PubMed: 19687337]
13. Courneya KS, Stevinson C, McNeely ML, Sellar CM, Friedenreich CM, Peddle-McIntyre CJ, et al. Effects of supervised exercise on motivational outcomes and longer-term behavior. *Med Sci Sports Exerc.* 2012; 44(3):542–9. Epub 2011/08/05. [PubMed: 21814149]
14. Rabin C, Pinto B, Dunsinger S, Nash J, Trask P. Exercise and relaxation intervention for breast cancer survivors: feasibility, acceptability, and effects. *Psychooncology.* 2009; 18(3):258–66. [PubMed: 18473397]
15. Blaauwbroek R, Bouma MJ, Tuinier W, Groenier KH, de Greef MH, Meyboom-de Jong B, et al. The effect of exercise counselling with feedback from a pedometer on fatigue in adult survivors of

childhood cancer: a pilot study. *Support Care Cancer*. 2009; 17(8):1041–8. Epub 2008 Nov 18. [PubMed: 19015892]

16. Ottenbacher AJ, Day RS, Taylor WC, Sharma SV, Sloane R, Snyder DC, et al. Long-term physical activity outcomes of home-based lifestyle interventions among breast and prostate cancer survivors. *Support Care Cancer*. 2012; 17:17.
17. Demark-Wahnefried W, Morey MC, Sloane R, Snyder DC, Miller PE, Hartman TJ, et al. Reach out to enhance wellness home-based diet-exercise intervention promotes reproducible and sustainable long-term improvements in health behaviors, body weight, and physical functioning in older overweight/obese cancer survivors. *J Clin Oncol*. 2012; 21:21.
18. Carson JW, Carson KM, Porter LS, Keefe FJ, Seewaldt VL. Yoga of Awareness program for menopausal symptoms in breast cancer survivors: results from a randomized trial. *Support Care Cancer*. 2009; 17(10):1301–9. Epub 2009 Feb 12. [PubMed: 19214594]
19. Bourke L, Doll H, Crank H, Daley A, Rosario D, Saxton JM. Lifestyle intervention in men with advanced prostate cancer receiving androgen suppression therapy: a feasibility study. *Cancer Epidemiol Biomarkers Prev*. 2011; 20(4):647–57. [PubMed: 21335510]
20. Wong P, Muanza T, Hijal T, Masse L, Pillay S, Chasen M, et al. Effect of exercise in reducing breast and chest-wall pain in patients with breast cancer: a pilot study. *Curr Oncol*. 2012; 19(3): 129–35. [PubMed: 22670089]
21. Rogers LQ, Hopkins-Price P, Vicari S, Markwell S, Pamentier R, Courneya KS, et al. Physical activity and health outcomes three months after completing a physical activity behavior change intervention: persistent and delayed effects. *Cancer Epidemiol Biomarkers Prev*. 2009; 18(5): 1410–18. [PubMed: 19383889]
22. von Gruenigen V, Frasure H, Kavanagh MB, Janata J, Waggoner S, Rose P, et al. Survivors of uterine cancer empowered by exercise and healthy diet (SUCCEED): a randomized controlled trial. *Gynecol Oncol*. 2012; 125(3):699–704. [PubMed: 22465522]
23. May AM, Korstjens I, van Weert E, van den Borne B, Hoekstra-Weebers JE, van der Schans CP, et al. Long-term effects on cancer survivors' quality of life of physical training combined with cognitive-behavioral therapy: results from a randomized trial. *Support Care Cancer*. 2009; 17(6): 653–63. [PubMed: 18953578]
24. Walsh JM, Hussey J, Guinan E, O'Donnell D. Pragmatic randomized controlled trial of individually prescribed exercise versus usual care in a heterogeneous cancer survivor population: a feasibility study PEACH trial: prescribed exercise after chemotherapy. *BMC Cancer*. 2010; 10(42) Epub 2010 Feb 15.
25. James EL, Stacey F, Chapman K, Lubans DR, Asprey G, Sundquist K, Boyes A, Girgis A. Exercise and nutrition routine improving cancer health (ENRICH): the protocol for a randomized efficacy trial of a nutrition and physical activity program for adult cancer survivors and carers. *BMC Public Health*. 2011; 11(236)
26. Rogers LQ, McAuley E, Anton PM, Courneya KS, Vicari S, Hopkins-Price P, et al. Better exercise adherence after treatment for cancer (BEAT Cancer) study: rationale, design, and methods. *Contemp Clin Trials*. 2012; 33(1):124–37. Epub 2011/10/11. [PubMed: 21983625]
27. Chinapaw MJ, Buffart LM, van Mechelen W, Schep G, Aaronson NK, van Harten WH, et al. Alpe d'HuZes cancer rehabilitation (A-CaRe) research: four randomized controlled exercise trials and economic evaluations in cancer patients and survivors. *Int J Behav Med*. 2012; 19(2):143–56. [PubMed: 21556821]
28. Velthuis MJ, May AM, Koppejan-Rosenbrink RA, Gijzen BC, van Breda E, de Wit GA, Schroder CD, Monninkhof EM, Lindeman E, van der Wall E, Peeters PH. Physical Activity during Cancer Treatment (PACT) Study: design of a randomised clinical trial. *BMC Cancer*. 2010; 10(272) Epub 2010 Jun 9.
29. Livingston PM, Salmon J, Courneya KS, Gaskin CJ, Craike M, Botti M, Broadbent S, Kent B. Efficacy of a referral and physical activity program for survivors of prostate cancer [ENGAGE]: rationale and design for a cluster randomised controlled trial. *BMC Cancer*. 2011; 11(237) Epub 2011 Jun 13.
30. Galvao DA, Taaffe DR, Cormie P, Spry N, Chambers SK, Peddle-McIntyre C, Baker M, Denham J, Joseph D, Groom G, Newton RU. Efficacy and safety of a modular multi-modal exercise

program in prostate cancer patients with bone metastases: a randomized controlled trial. *BMC Public Health*. 2011; 11(517) Epub 2011 Dec 13.

31. Littman AJ, Tang MT, Rossing MA. Longitudinal study of recreational physical activity in breast cancer survivors. *J Cancer Surviv*. 2010; 4(2):119–27. Epub 2010 Feb 24. [PubMed: 20180037]
32. Chambers SK, Lynch BM, Aitken J, Baade P. Relationship over time between psychological distress and physical activity in colorectal cancer survivors. *J Clin Oncol*. 2009; 27(10):1600–6. Epub 2009 Mar 2. [PubMed: 19255326]
33. Courneya KS, Friedenreich CM, Reid RD, Gelmon K, Mackey JR, Ladha AB, Proulx C, Vallance JK, Segal RJ. Predictors of follow-up exercise behavior 6 months after a randomized trial of exercise training during breast cancer chemotherapy. *Breast Cancer Res Treat*. 2009; 114(4):179–87. Epub 2008 Apr 4. [PubMed: 18389368]
34. Midtgaard J, Rossell K, Christensen JF, Uth J, Adamsen L, Rorth M. Demonstration and manifestation of self-determination and illness resistance—a qualitative study of long-term maintenance of physical activity in posttreatment cancer survivors. *Support Care Cancer*. 2012; 20(9):1999–2008. Epub 2011 Nov 15. [PubMed: 22083498]
35. Fitzpatrick TR, Remmer J. Needs, expectations and attendance among participants of a cancer wellness centre in Montreal, Quebec. *J Cancer Surviv*. 2011; 5(3):235–46. Epub 2011 Mar 3. [PubMed: 21369842]
36. WHO. WHO International Classification of Functioning, Disability and Health (ICF). World Health Organization; 2001. [updated December 02, 2010; cited 2013 Oct 17]; Available from: <http://www.who.int/classifications/icf/en/>
37. Shubert TE, Altpeter M, Busby-Whitehead J. Using the RE-AIM Framework to translate a research-based falls prevention intervention into a community-based program: lessons learned. *J Saf Res*. 2011; 42:509–16.
38. Wilson KM, Brady TJ, Lesesne C, on behalf of the NCCDPHP Work Group in Translation. An organizing framework for translation in public health: the Knowledge to Action Framework. *Prev Chronic Dis*. 2011; 8(2)
39. Sander AP, Wilson J, Izzo N, Mountford SA, Hayes KW. Factors that affect decisions about physical activity and exercise in survivors of breast cancer: a qualitative study. *Phys Ther*. 2012; 92(4):525–36. [PubMed: 22156026]
40. Pollack LA, Hawkins NA, Peaker BL, Buchanan N, Risendal BC. Dissemination and translation: a frontier for cancer survivorship research. *Cancer Epidemiol Biomarkers Prev*. 2011; 20(10):2093–8. [PubMed: 21980017]
41. Cormie P, Galvao DA, Spry N, Joseph D, Taaffe DR, Newton RU. Functional benefits are sustained after a program of supervised resistance exercise in cancer patients with bone metastases: longitudinal results of a pilot study. *Support Care Cancer*. 2014; 22(6):1537–48. [PubMed: 24424484]
42. McColl MA, Shortt S, Godwin M, Smith K, Rowe K, O'Brien P, et al. Models for integrating rehabilitation and primary care: a scoping study. *Arch Phys Med Rehabil*. 2009; 90:1523–31. [PubMed: 19735780]
43. Kessler RS, Purcell EP, Glasgow RE, Klesges LM, Benkeser RM, Peek CJ. What does it mean to “employ” the RE-AIM model? *Eval Health Prof*. 2013; 36(1):44–66. [PubMed: 22615498]
44. Glasgow RE, Marcus AC, Bull SS, Wilson KM. Disseminating effective cancer screening interventions. *Cancer*. 2004; 101(5 Suppl):1239–50. [PubMed: 15316911]

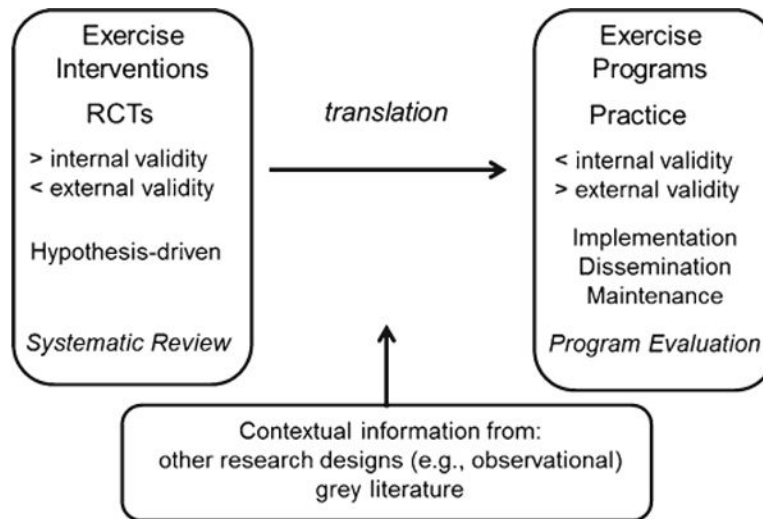


Fig. 1.
Conceptual design of the scoping study

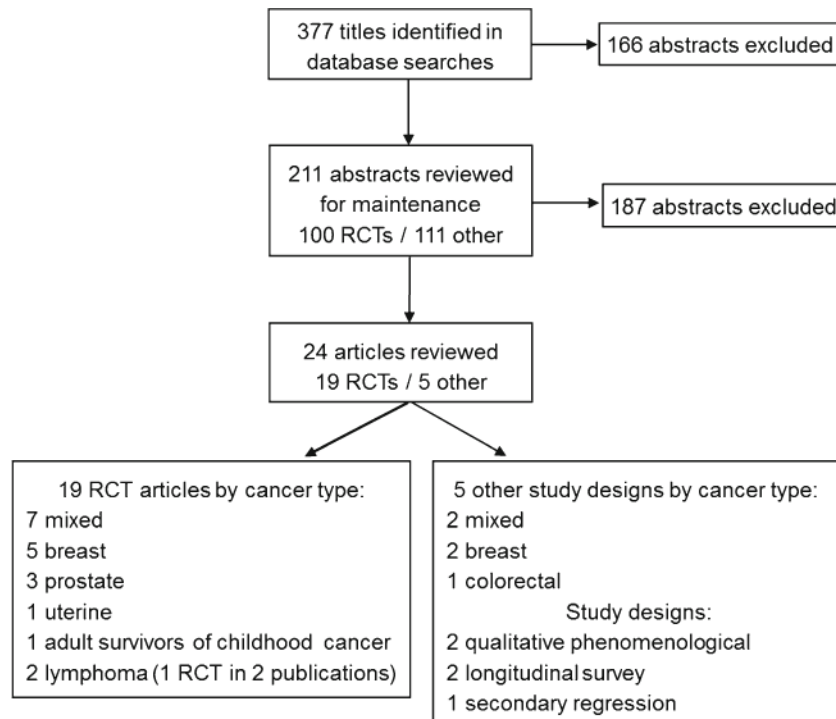


Fig. 2.
Publication selection and screening

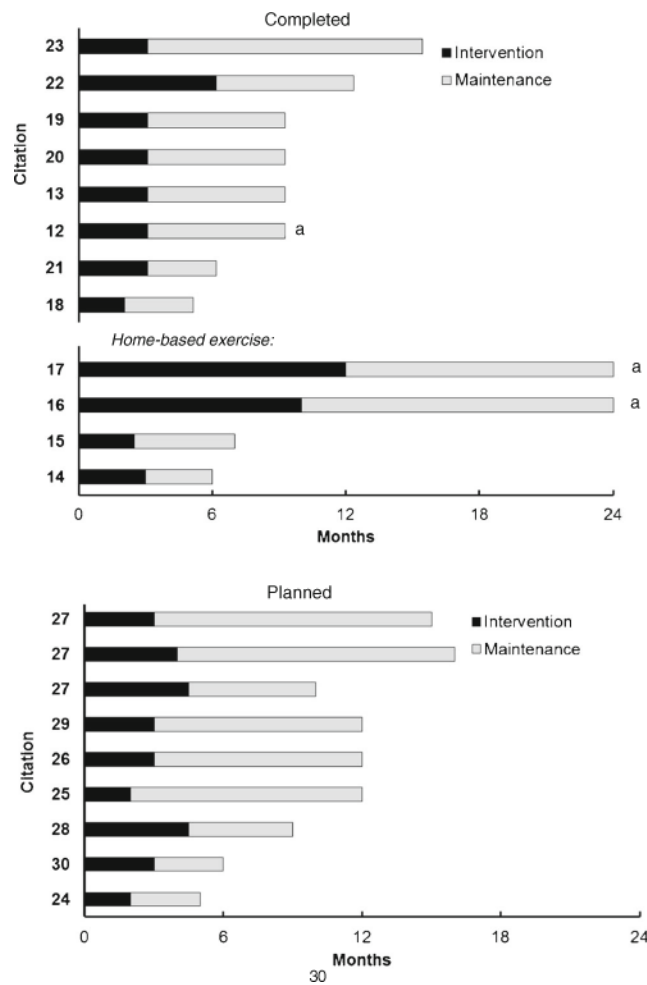


Fig. 3. Exercise intervention and maintenance intervals for the completed and planned RCTs. *a* changes in primary outcome not maintained. Citations 12 and 13 represent two separate publications of the same RCT. Citation 27 included three independent trials

Table 1

Overview of completed randomized controlled trials

First author publication date	Participant characteristics age Years ^a	Setting	Primary outcome	Significant intervention effects?	Effects maintained?	Enrolled (n) Attrition (%) ^b
Blaauwbroek 2009 [15]	Childhood w/ fatigue 30 (9)	Home	Fatigue	Yes	Yes	46 17
Bourke 2011 [19]	Advanced prostate Sedentary ^c 72 (60–87)	Academic health care	Exercise minutes	Yes	Yes	50 44
Cason 2009 [18]	Breast w/menopausal symptoms 54 (8)	Academic health care	Menopause symptoms	Yes	Yes	37 19
Courneya 2009 [12, 33]	Lymphoma ^d 53 (18–80)	Academic health care	Physical function	Yes	No	122 10
Courneya 2012 [13]	Lymphoma ^d 53 (18–80)	Academic health care	Exercise minutes	Yes	Yes	122 10
Denmark-Wahnefried 2012 [17]	Colorectal, breast, prostate Overweight/obese sedentary 73 (5)	Home	Physical function	Yes	No	641 24
May 2009 [23]	Many types w/physical complaints 49 (11)	Clinics	QoL	Yes	Yes	147 17
Ottensbacher 2012 [16]	Breast, prostate Sedentary 58 (11)	Home	Exercise minutes	Yes	No	486 18
Rogers 2009 [6, 21]	Breast Sedentary 53 (9)	Supervised + home	Exercise minutes	Yes	Yes	41 12
von Gruenigen 2012 [22]	Endometrial Overweight/obese 58 (10)	Group counseling + home	Weight loss	Yes	Yes	75 21
Wong 2012 [20]	Breast w/ pain 52 (42–59)	Supervised + home	Physical function	Yes	Yes	10 40

QOL quality of life

^a Mean (SD or range)^b Percentage of participants who completed the maintenance interval^c Includes not meeting general exercise recommendations^d Hodgkins and non-Hodgkins

Table 2

Overview of proposed randomized controlled trials

First author publication date	Participant characteristics age Years	Setting	Primary outcome	Enrollment (n) Estimated attrition (%)
Chinapaw 2012 [27]	Breast, colon, ovarian, lymphoma after chemotherapy 18–70	Academic health care	Aerobic fitness	400 n/a
Chinapaw 2012 [27]	Breast, colon, ovarian, lymphoma during chemotherapy 18–70	Academic health care	Aerobic fitness	360 n/a
Chinapaw 2012 [27]	Hematological or myeloma after stem cell transplant n/a	Academic health care	Aerobic fitness	120 n/a
Galvao 2011 [30]	Prostate with bone metastases Sedentary n/a	Academic health care	Physical function	90 20
James 2011 [25]	Mixed types >18	Group supervised + home	Step counts	150 n/a
Livingston 2011 [29]	Prostate n/a	Community fitness center	Exercise minutes	220 10
Rogers 2012 [26]	Breast Sedentary 18–70	Supervised + home	Exercise minutes	256 n/a
Velthuis 2010 [28]	Breast or colon, stage M0, newly diagnosed 25–75	Outpatient clinics	Fatigue	300 10
Walsh 2010 [24]	Mixed solid tumor Low fitness 21–69	Supervised + home	Aerobic fitness	64 15

n/a not available